Deformation Mechanism in Alumina at High Pressure and High Temperature	X17B1

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To investigate the rheological behavior of alumina, stress relaxation experiments were conducted on alumina powders with a grain size of 5 micron in a DIA-type multi-anvil apparatus at high pressure and temperature up to 10 GPa and 1500 K. Stress-strain were determined from the analysis of in situ x-ray diffraction peak broadening at the National Synchrotron Light Source X17B. At a pressure of 10 GPa and the room temperature, the yield strength of alumina is 9 GPa. At the temperature below 900 K, decay of stress with time is relatively slow. The stress exponent determined from the plot of log stress versus log time and of log strain rate versus log stress is larger than 30. The activation energy determined from Arrhenius plot is lower than 50 kJ/mol. Between 900 and 1100 K, a stress drop of 2 GPa with increasing time is achieved in a less than 10 minutes, then the stress approaches a constant value of about 3 GPa. The stress exponent is 10 - 30 and decreases with increasing temperature. The activation energy is 200 - 280 kJ/mol and decreases with increasing stress. Above 1300 K, the stress drops quickly to below 2 GPa. Results of strain rate, stress exponent and activation energy obtained from this study are consistent with values in the deformation map of Frost and Ashby (1982). Two deformation regimes can be identified based on above observations. Below 1100 K, stress relaxation is due to dislocation glide. Above 1300 K, stress relaxation is related to dislocation climb.